

A ns2-based simulation framework for performance evaluation of overlay networks

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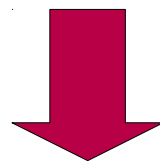
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- **Increasing number of P2P-based applications**
 - Streaming
 - Filesystems
 - ...
- **Need for tools to evaluate performance of overlay networks and routing algorithms**
 - Prototypes → too many nodes required
 - Analytical models → may be too complex
 - **Simulation**
- **Need for simulators of overlay networks**
 - **Already validated models and tools**

ns-2 Network simulator

- **Standard “de facto” in network simulation**
 - Widely adopted in scientific community
- **Little support for overlay (P2P) networks**
 - Some P2P feature in code for ad-hoc networks (specific for message routing in wireless links)
 - Gnutella sim (support only for Gnutella v0.4, requires patches and is not maintained)

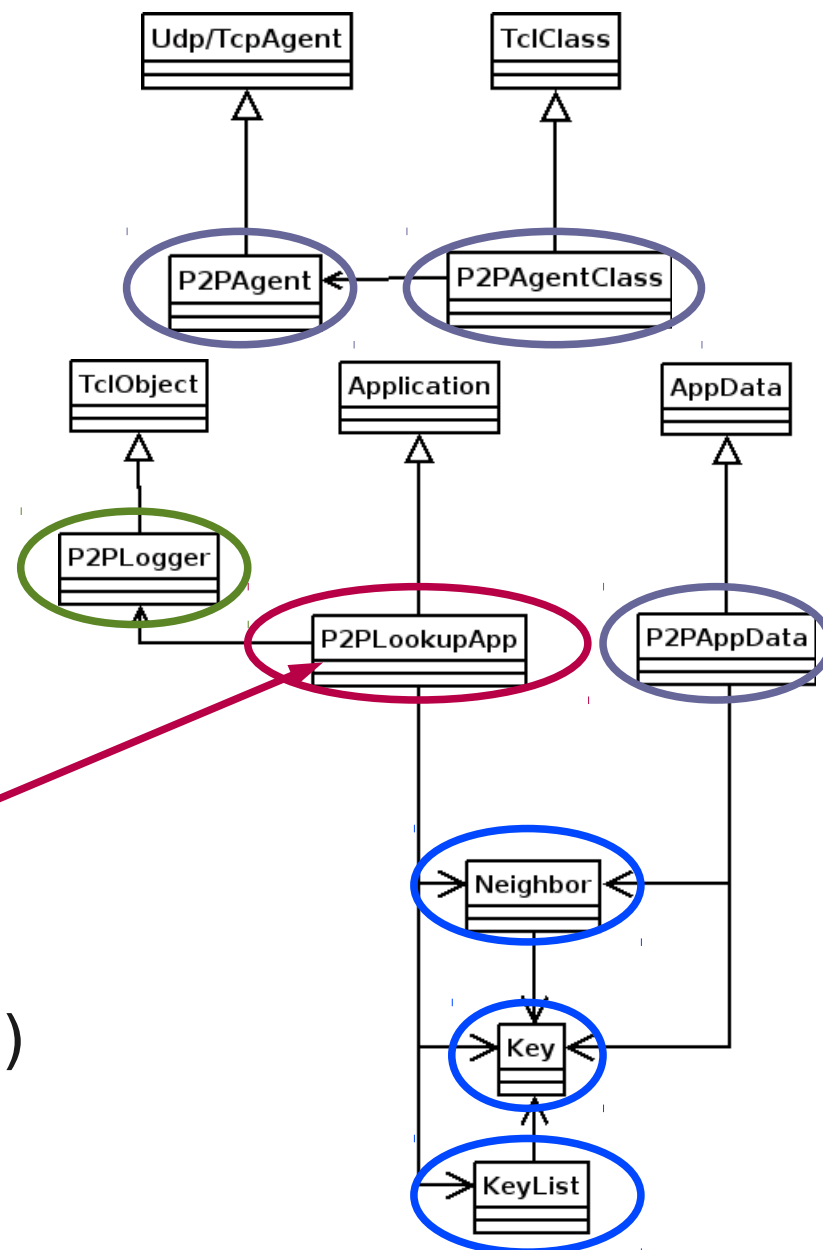


**Need of ns-2 extensions
for overlay networks**

- **Simulation framework for overlay networks**
 - Based on widely-accepted ns-2 simulator
 - Focus on performance evaluation
- **Elements of the framework**
 - Overlay routing algorithms (C++ classes)
 - Topology generators (TCL scripts)
 - Data analysis tools

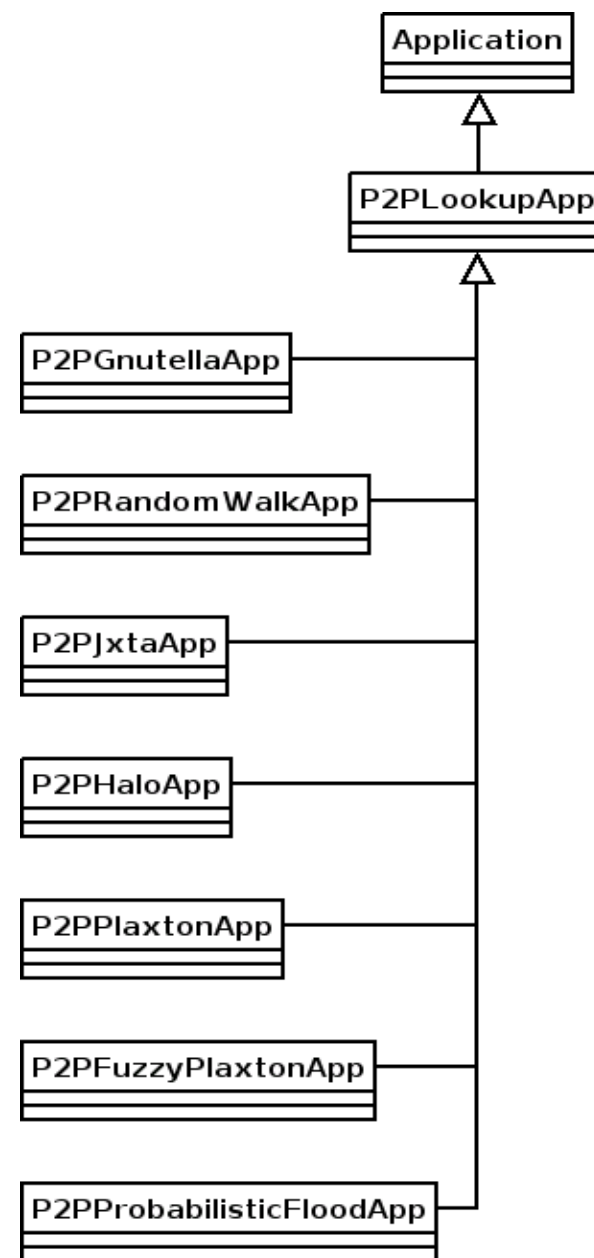
Overlay routing algorithms

- **Flexible base class hierarchy**
- **Object-oriented design: key classes**
 - Support classes
 - Transport-level data
 - Logging facility
 - P2P routing
- **Easy to extend**
 - New algorithm
 - New class (+ TCL binding)



Available algorithms

- **Unstructured networks**
 - Flood-based
 - Probabilistic flood
 - Random Walker
- **Semi-structured networks**
 - Support for supernodes
 - JXTA
- **DHT**
 - Pastry
- **Novel algorithms**
 - Halo
 - Fuzzy-DHT



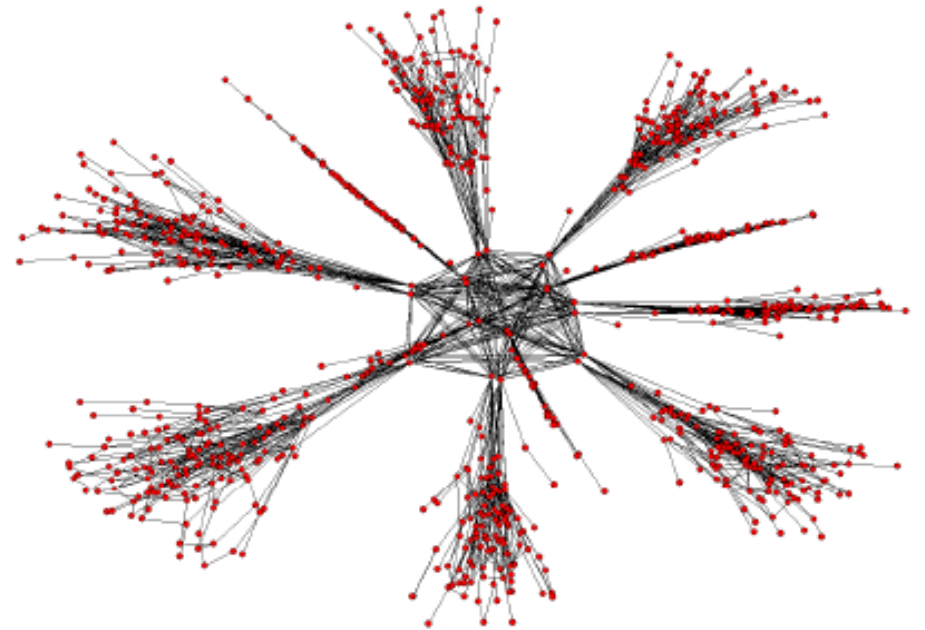
Logging facility

- **Separate logfile for P2P network operations**
- **Reports routing events:**
 - Hits
 - Miss
 - Query drop
- **For each event logs additional information such as:**
 - Simulation time of the event
 - Query TTL
 - Query key
 - Additional information (algorithm-supplied)
- **Log file easy to parse (regexp-friendly)**

- **Library of TCL scripts for the simulation**
 - Definition of Physical topology
 - Construction of overlay network
 - Logging of generated topologies
 - Population of overlay network (resources)
 - Setup of log files
 - Generation of queries
- **Multiple available functions for each phase**
- **TCL support for algorithms parameters**
- **TCL support for command-line options**
 - Sensitivity analysis can be carried out without changing C++ and TCL code

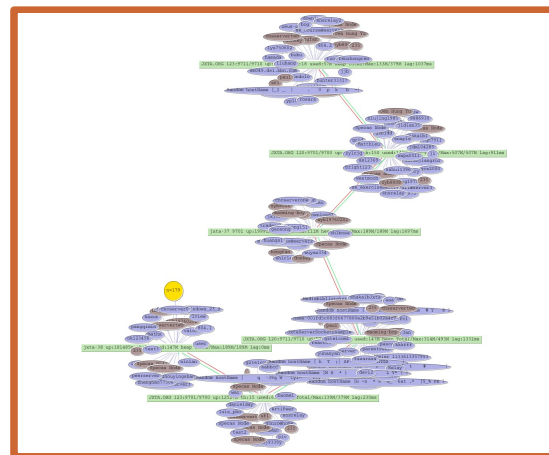
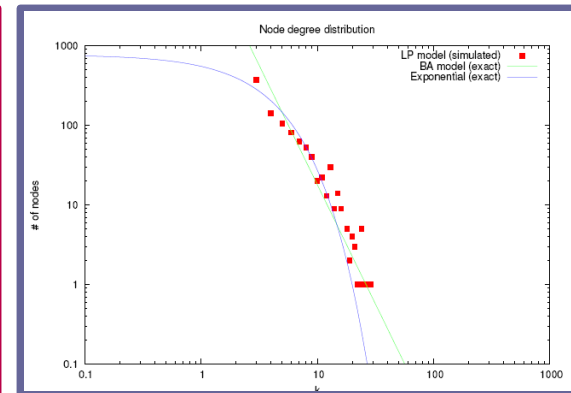
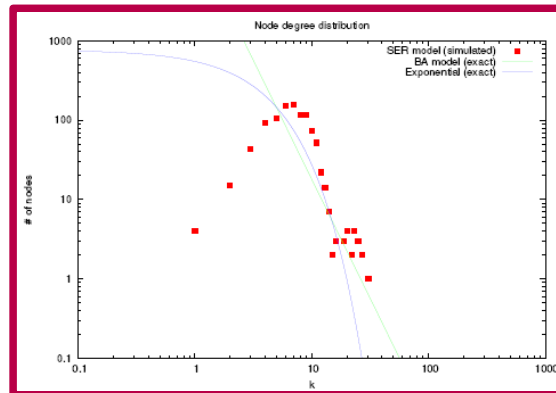
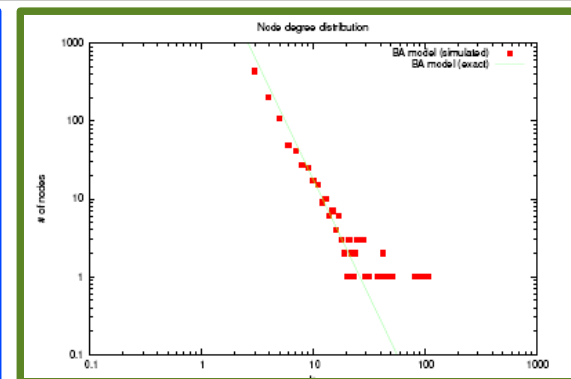
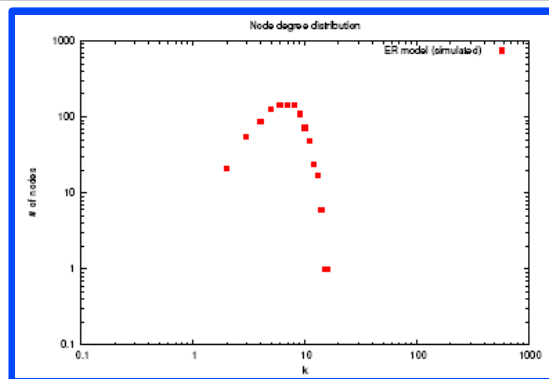
Physical network topologies

- **Star topology**
- **Real Network model (UniPR)**
- **Hierarchical topologies (Brite generated)**



Overlay network topologies

- **Neighborhood relationships**
- **Available topologies**
 - Poisson networks
 - Scale Free networks
 - Seeded networks
 - Locally preferential networks
 - JXTA growth (JXTANetMap)



TCL support for resources and queries

- **Trace-driven simulation**
 - Repeatable simulation
 - Support for multiple RNG seeds
- **Traces for resources**
 - Distribution of resources over nodes
- **Traces for queries**
 - Sequence of keys to search in the network
 - Support for “wildcard searches”
 - Queries can have different “selectivity” σ
 - Allows to evaluate overlay routing algorithms performance as a function of σ

Data collection and analysis tools

- **Automated analysis of logfile**

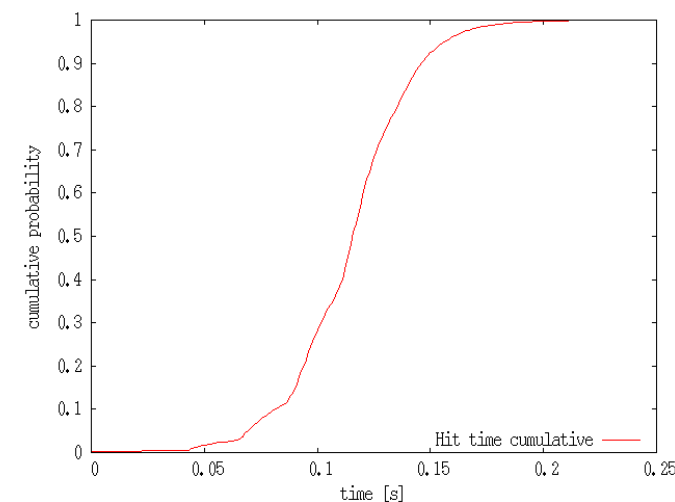
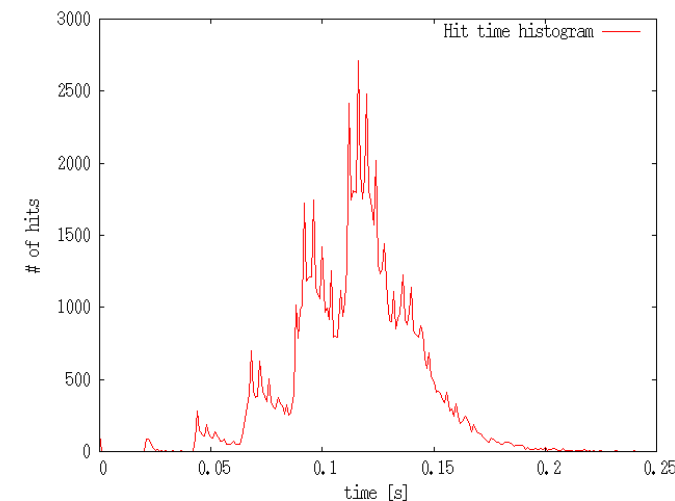
- Perl-based log parser
- P2P logs
- Standard ns-2 logs
- Topology logs

- **Automatic statistic extraction**

- Histograms
- Cumulative distribution

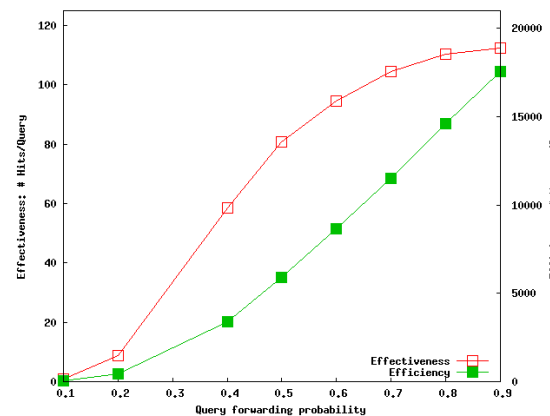
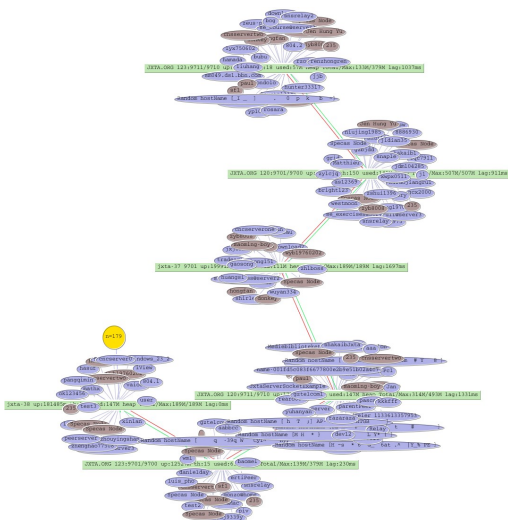
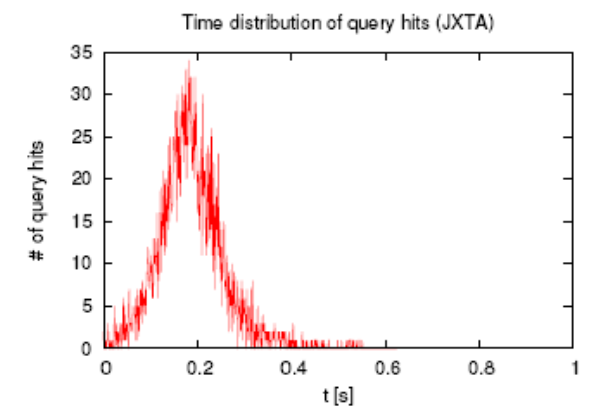
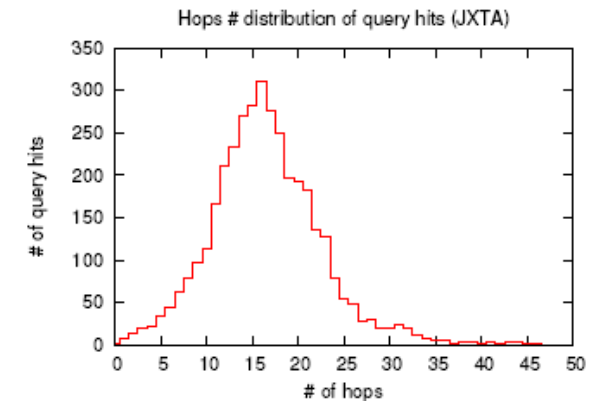
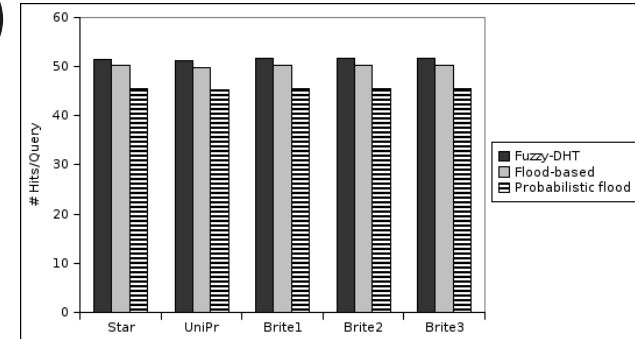
- **Automatic plotting**

- Template gnuplot files



Available analyses

- **Hit rate** (# of hits/theoretical max)
 - Exact searches
 - Wildcard-based searches
- **TTL of hits**
- **Time of hits**
- **Overhead** (# of pkts per query)
- **Topology of overlay network**



Experimental testbed

- **CASPUR Cluster**
 - 40 Nodes, dual AMD 64 CPU, 8GB RAM, SUSE Linux
 - OpenPBS batch scheduler
- **WebLAB Cluster**
 - 20 Nodes, Intel Xeon CPU, 1GB RAM, Debian Linux
- **UniPR Cluster**
 - 7 Nodes, Intel Pentium IV, 1GB RAM, Ubuntu Linux
- **Simulator compiles and runs correctly in every environment (including 64 bit)**
- **Simulation of up to 4000 Nodes**

Publications

- M. Andreolini, R. Lancellotti P. S. Yu, *“A flexible and efficient lookup algorithm for Peer-to-Peer systems”*, Submitted for publication, 2006
- M. Amoretti, F. Zanichelli, G. Conte, *“Performance evaluation of advanced routing algorithms for unstructured Peer-to-peer Networks”*, ValueTools 2006
- M. Amoretti *“Peer-to-peer based Grid architectures”* Ph.D. thesis, 2006
- M. Andreolini, R. Lancellotti P. S. Yu, *“Analysis of peer-to-peer systems: workload characterization and effects on traffic cacheability”* MASCOTS 2004

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